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20 March 1959

MEMORANDUM FOR: Deputy Director (Plans)

THROUGH : Acting Chief, Development Projects Division, DD/P

SUBJECT : Granger Countermeasures Repeater, Mod 504.

1. The results of the flight testing of the Granger equipment last week show that the prototype box is not capable of adequate mechanical performance at high altitude. This particular set was originally designed and fabricated to operate in an environment of seven (7) psi. The later requirement of operating at the reduced pressure of 4.5 psi has caused repeated equipment malfunction.
2. The flight test phase of the prototype equipment is considered complete. Any further tests with this box would require major factory work at Granger, would delay any new program input a minimum of a month, and would have only a 50% chance of being successful at high altitude. Since each hour of flight test requires the coordination and utilization of two ground radar sites, two F-102 aircraft and at least one F-106 aircraft, at a probable cost of \$10,000 per hour or more, it is not deemed feasible to continue the tests on this piece of gear. The flights at high altitude have caused this "repeater" to breakdown to the point where proper action at low altitude cannot be expected. Ground checks of the equipment do not reveal the source of malfunction. The obvious conclusion, then, is that the reduced pressure in the box is creating electrical disturbance in the system. The most probable cause is corona in a transformer or one of the traveling wave tubes. The actual flight conditions of pressure, temperature, and aircraft vibration cannot be accurately duplicated in the Granger altitude chamber to more closely determine the source of trouble.
3. Since no more testing is to be performed on this equipment, it is appropriate that this review of the program be initiated.
4. The Granger Repeater was designed to effectively deny tracking information to an attacking aircraft utilizing conical scan, X band transmissions, pulse type radar. The aircraft with radar sets most closely approximating those expected to be encountered in the operational utilization of the U-2, are the F-34, F-102, and F-106.

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using the "lead-collision" mode. A series of tests was conducted against these aircraft types and in all cases the Granger Mod 504 demonstrated the capability to "break-lock" or to present erroneous tracking information to a degree to prevent successful launching of a beam riding missile, rockets, or the firing of guns by the attacking pilot. Although these tests were conducted from level flight tail chase mission profiles, the results of the Zoom Climb tests show that an aircraft with performance capabilities comparable to the F-104 will fly an attacking flight path well within the coverage of the 1/2 power cone of the jammer. An aircraft with less performance differential engaging a tail chase and snap-up intercept technique will also be in the area of maximum jammer effectiveness when the missile launch should occur. Due to the equipment malfunction, these tests were not conducted at maximum altitude. However, the theory associated with this type of electronic package does not deteriorate the performance with increase in altitude. There are necessary design changes such as larger gaps between terminals, low pressure transformers, etc., to obtain functional reliability in the reduced pressure environment. When the mechanical reliability is accomplished, the mission capability should be identical with the low altitude results.

5. There are, of course, attacking conditions which will negate the effect of the jammer. The lead-collision attack at large "angle off" will place the attacker outside the cone of effective countermeasure. This attack method does require the pilot to perform many cockpit maneuvers simultaneously to successfully accomplish the attack. A similar pilot restriction occurs when using the tail chase snap-up technique at close range and large pitch altitude angles so as to be forward of the effective jammer cone. A more serious system deficiency is that the Granger box will not perform effective jamming when under stimulation by more than one X band radar set. This is a considerable condition of tactics of the attacking aircraft and/or X band tracking by the ground radar site. A preliminary investigation of the enemy tactics, however, reduces the probability of such a situation. Generally, the GCI radar is utilizing S band radar to direct one aircraft at a time into a tail chase attack pattern. No protection is offered against infra-red type detectors or sights, infra-red missiles, or beacon seeking missiles. No such protection was anticipated or specified for the system.

6. Conclusion: Realizing the limitations of the flight test program restrictions requiring all tests to be conducted at 30,000 feet or lower, the following conclusions are submitted:

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a. The Granger Countermeasures Repeater, Mod 504, satisfactorily performs the design mission specification of effective tracking angle jamming of attacking AI radars. The limitation of the jamming is restricted to conical scan, X band, pulse radar sets using a scan rate of 25 cps to approximately 150 cps.

b. The results to be anticipated at high altitude are identical with those of the test program when a mechanically reliable system has been fabricated.

c. Granger Associates has a high degree of confidence that a high altitude system can be built in three months.

d. The system will not be effective when under attack by two or more simultaneous X band radar sets.

e. The prototype box cannot be used for further testing without complete overhaul by the factory. Such work would require approximately one month to complete.

7. Recommendations: For future considerations of the Mod 504 program, the following recommendations are made:

a. Except for a very limited amount of high altitude testing of a production type system, the Granger Repeater should be terminated as an R & D program. The box should be released to CHALICE Operations for any further considerations and/or action.

b. That a re-evaluation be made of the anticipated attacking aircraft radars to determine the timeliness of this type of countermeasures equipment.

c. If production of this equipment is desired, two systems should be built for the high altitude testing prior to the production of the many units desired. ~~A full production of the many units desired.~~ A full production contract should be for one jammer per operational aircraft, plus necessary spares.

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by  8. The following cost and delivery estimates were submitted of Granger Associates:

1 box	\$43,000
2 boxes	\$33,500 each
10 boxes	\$25,700 each

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These costs do not include spare parts, the outside container produced by Lockheed, installation, or field service representatives. The delivery of the jammers would be as follows:

1st box	3 months
2nd box	1 month later
other boxes	2 per month thereafter

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MAJOR, USAF

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- 3 - Ops IPD-ID/P
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- 6 - Lt. Col. [redacted]

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